

Physiology of the Female Reproductive System (2)

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ILOs

By the end of this lecture the student should be able to:

- Explain the cyclic changes in the uterine cervix, vagina and breasts.
- Describe the indicators for ovulation
- Explain the functions of estrogen and progesterone

Cyclical changes in the uterine cervix

- **In the follicular phase**
 - Estrogen makes the cervical mucus thinner and more alkaline, which promote the survival and transport of sperm.
 - The mucus is thinnest at the time of ovulation, and its elasticity (spinnbarkeit), increases.
 - When a thin layer is spread on a slide it dries in an arborizing, fern-like pattern.
- **In the luteal phase**
 - Progesterone makes the mucus thick, tenacious, and cellular and fails to form the fern pattern so plug cervical opening and sperm cannot penetrate thick mucus.

Vaginal cycle

- **In the follicular phase**
 - Under the influence of estrogens, the vaginal epithelium becomes cornified and this can be identified in the vaginal smear.
- **In the luteal phase**
 - Under the influence of progesterone, thick mucus is secreted, and the epithelium proliferates and becomes infiltrated with leukocytes.

Cyclical changes in the breasts

- Although lactation normally does not occur until the end of pregnancy, cyclical changes take place in the breasts during the menstrual cycle.
- Estrogens cause proliferation of mammary ducts.
- Progesterone causes growth of lobules and alveoli.
- Breast swelling, tenderness, and pain experienced by many women during the 10 days preceding menstruation are probably due to distention of the ducts, hyperemia, and edema of the interstitial tissue of the breast.
- All these changes regress, along with the symptoms, during menstruation.

Indicators of ovulation

- Rise of basal body temperature (starts 1–2 days after ovulation) due to the increase in progesterone secretion, since progesterone is thermogenic.
- Secretory changes in endometrium
- Thick cervical mucus by effect of progesterone
- Sudden increase in LH level
- Lower abdominal pain
- Increase progesterone excretion in urine (pregnanediol)

Estrogen

- It is secreted by the ovary: granulosa cells of the ovarian follicles and the corpus luteum, adrenal cortex (small amount), and the placenta.
- There are two peaks of secretion:
 - one just before ovulation
 - one during the mid luteal phase.

Forms of Estrogen

- The naturally occurring estrogens are 3 forms: β -estradiol (most potent), estrone and estriol

Functions of estrogen

A primary function of the estrogens is to cause:

- Cellular proliferation and growth of the tissues of the sex organs and other tissues related to reproduction.
- Development of secondary sexual characteristics of female

I. Effects on the female genitalia

- Facilitates the growth of the ovarian follicles. It is essential for ovum maturation and release.
- Stimulates granulosa cell proliferation, which leads to follicle maturation
- Stimulates growth and maturation of entire female reproductive tract
- Stimulates the growth of endometrium and myometrium (increases the amount of uterine muscle and its content of contractile proteins).
- Proliferation of endometrium during follicular phase of ovarian cycle
- Increases uterine blood flow
- Increases the excitability and motility of uterus
- Increases uterine responsiveness to oxytocin during late pregnancy and triggers onset of labour by
 - inducing synthesis of myometrial oxytocin receptors
 - increasing myometrial gap junctions so that the uterus can contract as a coordinated unit in response to oxytocin
- Makes cervical mucus thin and watery during follicular phase to permit sperm penetration
- Enhances transport of sperm from vagina to oviduct by stimulating upward contractions of uterus and oviduct

II. Effects on endocrine organs

- Controls GnRH and gonadotropin secretion
 - Rising moderate levels of estrogen (in early follicular phase) decreases GnRH, FSH and LH (negative feedback)
 - High levels of estrogen (in late follicular phase) increase LH secretion triggering LH surge (positive feedback).
- Increases secretion of angiotensinogen and thyroid-binding globulin

III. Effects on breasts

- At puberty
 - Growth and enlargement of breast by:
 - Development of stromal tissue of breast
 - Growth of duct system
 - Deposition of fat in breast
 - Pigmentation of the areolas
- During gestation
 - Stimulates duct development in the breasts

- Stimulates secretion of prolactin
- Inhibits milk secreting action of prolactin

IV. Female secondary sex characteristics

Promotes development of female secondary characteristics

- Feminine fat distribution in breast and buttocks
- Narrow shoulders and broad hip
- Thighs that converge and arms that diverge (wide carrying angle).
- High pitched sound
- More scalp hair
- Less body hair
- Pubic hair is flat-topped pattern
- Skin is soft and warm
- Develops sex drive (libido) at puberty and maintains it in adult females by a direct effect on certain neurons in the hypothalamus

However, growth of pubic and axillary hair in both sexes is due primarily to androgens rather than estrogens.

V. Non-reproductive effects

- Promotes fat deposition in subcutaneous tissues
- Increases bone density and bone growth (by increasing osteoblastic activity and decreasing osteoclastic activity) at puberty and for several years
- Closes the epiphyseal plates
- Slight increase in total body proteins but this effect is less than testosterone.
- Sodium and water retention just before menstruation and increase secretion of aldosterone in the luteal phase, and this also contributes to the premenstrual fluid retention.
- Improves blood cholesterol by increasing HDL and decreasing LDL
- Promotes vasodilatation by increasing nitric oxide production in arterioles (cardioprotective)
- Makes the secretion of sebaceous glands more fluid so it counteracts effect of testosterone in production of black heads and acne

Progesterone

It is secreted by the corpus luteum, the placenta, and (in small amounts) the ovarian follicle.

Functions of progesterone

I. Effects on the female genitalia

- Promotes secretory (progestational) changes in the uterine endometrium, thus preparing the uterus for implantation of the fertilized ovum
- Antiestrogenic effect on the myometrial cells, decreasing their excitability and their sensitivity to oxytocin and motility of uterine muscle thus prevents abortion.
- Decreases the number of estrogen receptors in the endometrium and increases the formation of less active estrogens.
- Promotes formation of a thick mucus plug in cervical canal

II. Effects on breasts

- On breasts:
 - Stimulates the development of lobules and alveoli
So, alveolar cells proliferate, enlarge and become secretory
However, progesterone does not cause the alveoli to secrete milk
 - Inhibits milk secreting action of prolactin during gestation so alveoli do not secrete milk

III. Effects on endocrine organs

- Exerts –ve feedback effect on hypothalamus and anterior pituitary
→ decreases secretion of GnRH, FSH and LH during luteal phase
→ prevents growth of new follicle and ovulation during luteal phase

IV. Non-reproductive effects

- Progesterone is thermogenic increases basal body temperature at time of ovulation
- Large doses of progesterone produce natriuresis, probably by blocking the action of aldosterone on the kidney
- It stimulates respiration.